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ABSTRACT

The forest pests discussed in this guide are weeds, insects, diseases, and vertebrates. The guide gives information about types of forests, characteristics of common forest pests, pest control methods, pesticides and application equipment used in forestry, and environmental and human hazards. (Author/BB)

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FOREST PEST CONTROL

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This training guide is intended to provide you with information needed to meet the Environmental Protection Agency standards on Forest Pest Control and prepare you to take the written examination for certification. However, it does not provide all the knowledge needed for effective forest pest control. Additional information can be obtained from Cooperative Extension, University of California, and from your county agricultural commissioner.

PREFACE

Federal and state regulations establish general and specific standards that you must meet before you can use restricted use pesticides. University of California Cooperative Extension offices can provide materials which you may study to help you meet the *general* standards for certification. The guide contains basic information to help you meet the *specific* standards for commercial applicators who are engaged in forest pest control in California.

This guide will give you information about:

- types of forests,
- characteristics of common forest pests,
- pest control methods,
- pesticides and application equipment used in forestry, and
- environmental and human hazards.

Because of its climatic and topographical diversity, California has as least five major forest types. Each of these is characterized by the major forest species present, and each has its unique insect, disease, and weed problems. It is beyond the scope of this manual to provide you with detailed information on controlling pests in every type of forest. However, it is our intention to supply generalized information which will inform you of some of the important biological, ecological, and health aspects of pesticide use in the forest. Additionally we hope to supply you with some basic information on the major forest pests in California.

The use of pesticides in the forest environment presents particularly difficult environmental and regulatory problems. You, as a pesticide applicator, should be aware of these problems. Use pesticides intelligently and safely at all times.

INTRODUCTION

Control of forest pests is a long-term proposition. The goal is to keep pest populations at a level low enough to prevent damage to forest resources. Chemical pest control, when necessary, should be combined with other management methods to minimize recurrence of the pest problems.

Some post-harvesting practices have left forest problems such as weed trees, brush, and weed-covered lands without commercial stands. Wildfires have left extensive areas of brush where trees once grew. Increased travel of man has helped introduce weeds, insects, diseases, and animals which cause widespread damage. Forests are attractive to people for the beauty of the scenery, the abundance of wildlife, and the quiet environment. Choose effective pest control methods that are the least disruptive of these values.

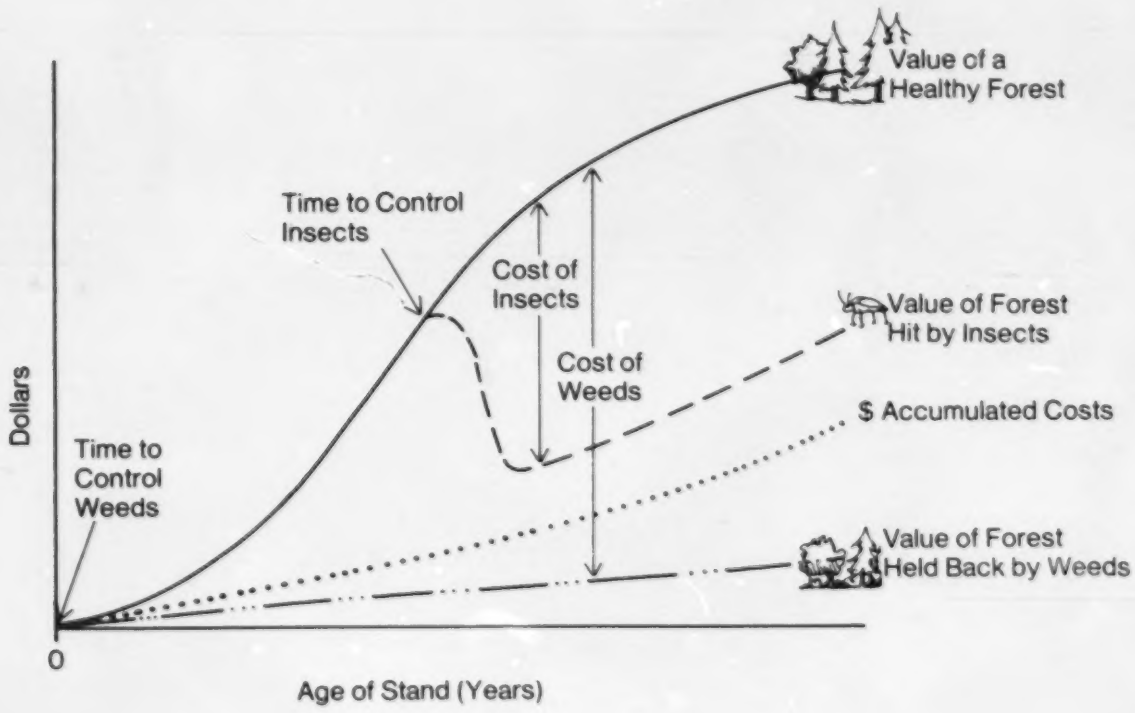
Tree cover affects all other forest sources (water, wildlife, and esthetics). Methods used to improve or protect the tree cover have a great influence on the other resources. Pesticides are not generally used except to improve the timber. Take care to avoid injury to the other resources.

Habitat management can control many forest pests. Good vegetation control and management may not only help to control pests, but will enhance the timber production and may permanently solve some forest problems.

FOREST TYPES

The major commercial forest types of California are:

- Pine
- Redwood
- Douglas fir
- Fir
- Pine/Douglas fir/fir.



FOREST PESTS—

WEEDS

A common definition of a weed is "a plant out of place." Therefore, any plant species which interrupts or interferes with a land-management objective could be deemed a weed. Forest weeds seriously compete with young conifers or established trees, thus limiting future supplies of high-quality forest products. Weeds in forests may be classed as:

- herbaceous weeds,
- brush, and
- weed trees.

Herbaceous Weeds

Herbaceous weeds include both annual and perennial:

grasses, and
broadleaved plants.

Herbaceous weeds compete with seedlings in new conifer plantations. The seedlings may develop poorly or die, especially in time of drought. Herbaceous weeds also create favorable cover for tree-damaging animals such as mice, gophers, and moles.

Brush

Brush includes:

- woody shrubs, and
- stump or crown sprouts of noncommercial
- trees.

Dense brush keeps light from tree seedlings, and can deprive taller commercial species of water and nutrients. It interferes with planting and can create habitat for wildlife species that may damage tree seedlings.

Brush Trees

Weed trees often cause significant losses in timber production. They affect both young and old commercial trees within the stand. Included are:

noncommercial hardwood and conifer species,
deformed, defective, or undersized individuals of commercial species (such as crooked trees or those with heart rot), and
certain commercial species growing in a location where they are poorly adapted.

WEED CONTROL METHODS

The methods used for weed control in forests depend upon the weed situation and the manner in which the conifer stand is being managed. Methods most often employed in forestry are:

- hand hoeing of herbaceous weeds,
- hand cutting,
- mechanical control, and
- chemical control.

Hand hoeing

Forest nurseries, seed orchards, and Christmas tree plantings should be free of weeds. Herbaceous weed control is especially critical in these high-value forest crops and requires a continuing effort throughout the growing season. Mechanical and hand weeding practices are still common.

Hand cutting

Hand cutting of brush and weed trees is rarely practical on a large scale. However, such operations may be applicable to small wood lots or commercial thinning of conifer stands. Many brush and weed-tree species readily sprout from stumps or roots following top removal, thus making the benefits of hand cutting short-lived.

Mechanical control

Brush removal with a track-layer tractor fitted with a blade or brush rake is applicable where trees are grown in rows. Similar mechanical tools are utilized in site preparation operations where brush as well as any existing small conifers are removed. Unless roots and crowns are lifted free from the soil, most broadleaf woody species will readily reestablish.

Rotary mowers and tillage implements have some utility for herbaceous weed control in seed orchards and Christmas tree plantings.

Chemical control

Herbicides are chemicals which kill or suppress unwanted plants. They are used in forestry to control undesirable vegetation and thus for enhancing the growth of conifers. Herbicides generally move very little in forest soils. They are broken down in place by micro-organisms, sunlight, and chemical reactions. A compound having an effective life of several months will usually move less than a foot or two from the site of application. Therefore, herbicides are not a serious threat to water supplies or fish unless they are placed directly (especially by spillage) into forest streams or on areas which will become waterways during storm periods. Certain herbicides can be used effectively for control of herbaceous weeds, brush, and weed trees.

The advantages of using herbicides are:

- Economy: compared to alternate control practices such as hand cutting or mechanical methods.
- Time saving: large areas can be covered in a relatively short time.
- Convenient in ease of application and labor requirement.
- Fewer re-treatments to control resprouting of herbaceous and wood perennials.
- Some herbicides are sufficiently selective to minimize or avoid damage to conifers.

The disadvantages or limitations of herbicides are:

- Success of weed control programs depends upon the selection of the proper type and formulation of herbicides or herbicide mixtures.
- Application timing is often critical in maximizing conifer tolerance and in gaining maximum weed control.
- Non-target plants in gardens or on farms may be adversely affected by spray or vapor drift, or through root uptake causing plant injury or residues.

Methods of Applying Herbicides

- Many herbicides are applied directly to foliage. Such herbicides move readily in the plant from the leaves to the areas of active growth, which are then inhibited. In some instances the herbicide may remain in the treated leaves; such applications (contact) are confined to the foliage treated.
- Direct cambium applications include basal stem treatments and cut-surface applications. Both are used to kill individual trees or tree-like shrubs. Basal stem treatments employ herbicide-oil solutions directly applied to bases of stems and trunks. Cut-surface applications involve placement of the herbicide into the vascular tissue of weed trees by injection, frill treatment, or application to freshly-cut stumps.
- Soil applications of specific herbicides are most used in forestry to minimize competition of annual herbaceous weeds for moisture. Such herbicides are taken up by weed seedlings and thus inhibit undesirable plant growth.

Herbaceous Weed Control

When herbaceous weeds predominate, aerial or ground applications of soil-active herbicides are used. Soil-active herbicides may be applied in combination with foliage-active herbicides. Control herbaceous weeds with herbicides labeled for this forest use only, since other herbicides may kill all ground cover for several years and cause soil erosion and loss of nutrients. Use banded applications in areas with summer rainfall. In dry-summer climates, short-residual herbicides permit winter ground cover to develop.

For herbaceous weed control in new plantings, apply herbicides in the spring before growth of tree seedlings begins. Chemicals that injure planted trees on contact may have to be applied before planting or be used as directed spray. Herbaceous weeds recover rapidly after treatment with contact herbicides. Use residual herbicides to extend weed control through the tree seedlings' first growing season.

Brush and Weed Tree Control

Preparation of land for planting. Mechanical and/or chemical control methods are employed with little attempt to preserve any conifer population present. Herbicides are applied on large areas, usually by aircraft. Herbicide selection is premised on maximum control of the target weed species. Apply herbicides during the early or middle part of the growing season. Dead tree or brush removal by controlled fire preceding planting is often helpful.

Release. This is selective control of brush or unwanted tree species to reduce competition and increase conifer survival and growth rate. Applications are made during the season when brush and hardwood trees will be controlled with the least damage to conifers.

Cut-surface applications of herbicides to individual trees. Release desirable tree species by using individual stem treatments on competing trees. Cut-surface treatments usually involves applying water-soluble amines or various other salts of herbicides in concentrated form to cut surfaces. Cut surfaces are created by:

Frilling—that is, encircling the bole with a series of overlapping single line ax cuts which penetrate the cambium. A herbicide must be applied to insure kill by preventing bridging. Apply the herbicide into the frill.

Felling the tree and wetting margins of cut stump surfaces with concentrated herbicide.

Trunk injection—using special tools (such as the tree injector or modified hatchets) that inject herbicide concentrate.

Putting granular herbicide (ammonium sulfamate) into ax-cut cuts spaced around the base of the tree near the ground line.

Directed basal stem application to individual trees consists of spraying a herbicide in oil solution on the bark of the lower 1 foot or bole and exposed roots to the point of runoff. The entire root collar must be treated without gaps. Remove debris first.

Soil applications of herbicides can be used to kill trees, but are not always effective. Use them with care to avoid leaving residues in soil that are harmful to desirable trees. Spot treatments are more useful than broadcast applications.

MORE HERBICIDE TERMINOLOGY

It is important to understand the terms used on herbicide labels to describe their uses in forestry. These terms include:

Reforestation—the process of establishing tree seedlings.

Site preparation—preparing an area for reforestation by clearing or other vegetation control.

Plantation weed control—using herbicides for selective weed control to insure survival and rapid growth of planted tree seedlings. This is one method of animal habitat management.

Release—applying selective herbicides to woody or herbaceous weeds competing with commercial crop species.

Desiccation—applying herbicides to vegetation in preparation for burning as part of site preparation.

Timber stand improvement—selective removal of undesirable trees to improve growing conditions for desirable trees.

Chemical precommercial thinning—removing all excess trees in a young forest by applying chemicals to individual trees. Herbicides labeled for basal spraying, cut-surface application, trunk injection, frilling, or stump treatment may be used for this purpose.

Preharvest drying of softwood timber—the treatment of trees with chemicals to allow timber to season before cutting. May also loosen bark and control insects and diseases. Herbicides registered for conifer thinning may be used for this purpose.

Dormant spray—applying before buds open in the spring, or after trees go dormant in the fall.

Early foliage spray—application while new growth is elongating rapidly, but after first leaves are fully expanded.

Summer foliage spray—application to mature foliage near midsummer.
Fall foliage spray—application in late summer to early fall, generally used with readily translocated herbicides.
Cut surface—includes trunk injection, bore-hole, frill, frill-girdle, girdle and stump treatment.
High volume ground spray—application of herbicide to low brush with power sprayer delivering enough volume to wet foliage to the drip point. Noncrop herbicides may be used when crop species are not present.
Low volume spray—application by aircraft or ground rig, including air blast sprayers at the rate of 30 gallons per acre or less. Does not soak foliage. Aircraft application must be specified on the label. Forestry use must appear on the label if crop species are affected.

INSECTS

The major groups of insects affecting California forests are:

- defoliators,
- bark beetles,
- sucking insects,
- shoot borers, and
- wood borers.

DEFOLIATORS include:

- Douglas-fir tussock moth,
- western spruce budworm,
- needle miners, and
- sawflies.

The larvae of defoliators feed on buds, flowers, and leaves of both hardwood and coniferous trees. Early spring defoliation often keeps the trees from fruiting, reducing regeneration potential.

Defoliation suppresses shoot development and growth rates. Repeated defoliation can kill the trees. Symptoms are the trees obviously stripped of foliage. One or more hatches may occur each year depending on species and climate. The nonpersistent insecticides are most commonly used for control. Insecticides are usually applied from aircraft:

- in low volumes of oil or water mixtures, or
- in ultra-low volumes of a few ounces per acre
- of undiluted formulation concentrate.

Timing of the application is critical to insure that:

the entire hatch has emerged or will be exposed in later sprays, and
damage has not progressed past a harmful point.

BARK BEETLES include:

- the western pine beetle,
- the mountain pine beetle,
- the Douglas-fir beetle,
- the Jeffrey pine beetle,
- the white-fir engraver.

Bark beetles normally kill some trees each year. In epidemic years, they kill large numbers in some regions. Their effects are most severe in unthrifty stands and under adverse weather conditions.

Mature insects enter the tree and lay eggs in channels etched between the bark and wood of conifers and certain hardwoods. The larvae feed on cambium tissue. As the tree dies, adults emerge and fly to another tree. Trees may also be killed by the fungi introduced by some beetles.

Several hatches of bark beetle may occur each year, depending on species and region. Since adults are exposed for only a short time, beetles are seldom a good target for insecticides.

Infested trees are sometimes felled and chemically treated. Insecticides are seldom used to control outbreaks except in recreational sites, seed orchards, Christmas tree plantations, or other high-value special-use areas.

SUCKING INSECTS include:

- the balsam woolly aphid,
- the Monterey pine aphid, and
- the black pine leaf scale.

Sucking insects feed on plant fluids below the surfaces of bark and leaves. Mass attacks reduce vigor and kill shoots and leaves. Entire trees or stands may be killed if infestation is extreme and continued for years.

Contact insecticides must be used as sprays. Coverage is seldom complete, especially for insects on lower leaf surfaces. Systemic insecticides within the tree have better control potential.

SHOOT BORERS include both moths and weevils. Examples are:

- the pine tip moth, and
- the white pine weevil.

Eggs are laid on both terminal and lateral shoots. Developing larvae bore down the pith, killing the shoot. Recognition is by dead shoots and presence of larvae in central channels. Borers seldom kill trees, but they slow tree growth and cause malformed seedlings.

Since some species of shoot borer have several hatches each season, use systemic insecticides.

WOOD BORERS include:

- ambrosia beetles,
- flatheaded borers, and
- roundheaded borers.

Wood borers channel in the tree bole and lower the quality of the wood. Secondary damage is caused by fungi that produce stains and mar the appearances and utility of products. Borers leave holes in the bark that frequently exude sap. There is no economical control by insecticides, except for protection of cut timber.

Insecticides

Few insecticides can be used for broadcast applications in forests. Forest insecticides are used mainly to combat widespread epidemics of defoliators such as tussock moth, spruce budworm, needle miners, and sawflies, in regional control programs, and to spot-treat individual plots in nurseries, seed orchards, and Christmas tree plantations.

Most of the large scale spray projects in California have involved the above-named species of defoliators.

Like herbicides, insecticides are not highly mobile in soil. Keep insecticides away from open water by leaving adequate buffer strips along streams and impoundments when applying by air.

DISEASES

In terms of losses to future forest production, the rusts, root rots, and dwarf mistletoes are the most important diseases.

Few fungicides are registered for use in forests. Diseases may cause heavy losses in forest nurseries. Some soil fumigants and fungicide sprays can be used in nurseries. Nursery diseases can be separated into these types:

- root and soilborne diseases, controlled by fumigation and fungicides,
- stem and branch diseases, and foliage diseases, may be prevented with fungicide sprays.

Many nurseries fumigate to control weeds and diseases. Fumigants are nonselective.

VERTEBRATES

Animals damage trees at all stages in the development of the forest.

Seed-eating birds and mammals can be an important limiting factor in natural forest regeneration.

Browsing animals like deer and rabbits can deform or kill seedlings.

Mice and mountain beaver can kill seedlings by completely debarking them.

Birds and rodents that feed on buds can seriously deform trees.

Pocket gophers, wild hogs, and mice can destroy root systems of saplings, and occasionally larger trees.

Bears, porcupines, mice, wood rats, and squirrels can kill larger trees by girdling.

Beaver, besides felling trees, cause extensive timber losses from water impoundments.

Sharp 45° Cut
Top Dies
Tattered Bark on Girdled Sapling from Antlers
Browsed Off Stem Blunt
Bears Strip Bark in Spring and Scrape Fresh Sapwood
Dying Top
Porcupines feed on Bark, Girdling, and Causing Top to Die Back

Control of vertebrates usually is not feasible except in intensively managed forests or in nurseries.

Cultural methods include the use of tree species on which the pest will not feed, and the use of planting stock large enough to be beyond the vulnerable stage.

Physical control includes fencing large tracts, installing protectors around individual trees, and shooting or trapping.

For additional information on vertebrates see applicator training guide: "Vertebrate Pest Control".

PESTICIDE LABELING

Forest lands are considered to be cropland when a stand of commercial trees is present. This means that "noncropland uses" listed on a pesticide label may not apply to forests. Pesticides used in forests, seed orchards, Christmas tree plantations, or nurseries must bear directions for use on the specific crop and pest species.

Some forestry uses are included on labels principally devoted to other uses. For example, pesticides may be applied to Christmas trees, seed orchards, or nurseries if the label gives directions for use:

on ornamentals or shade trees, including conifers, and

for the pest you need to control.

Herbicides registered for other crops, range, or non-crop lands may be used before crop trees are planted. Some pesticides registered for use in forestry may be tank mixed. In mixtures of two or more products, the rate of each component may not exceed the rate prescribed on its label. Check labels or recognized authority for details.

APPLICATION

Aircraft are used for most forest pesticides applications. Other techniques include the use of:

air blast sprayers—Air blast sprayers are used most often for applying herbicides to brush under conifer stands, or for selective brush control in regenerating stands. In these cases, the standing trees restrict air movement. This provides some drift control.

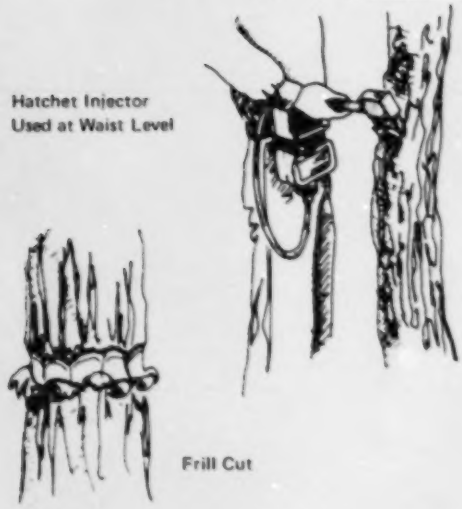
When using an air blast sprayer in forests:

Work on a calm day (less than 5 mph wind).

Apply herbicides only in timber production areas.
Follow local regulations regarding distance from crops.
Use operating pressure less than 20 psi.
Use the largest practical nozzle openings.
Do not spray under stands of sensitive desirable trees.
Do not spray near recreation areas.

- **tree injectors**—Tree injectors are used to control woody species that have passed the "brush" stage. A tree injector makes a wound through tree bark and places herbicide in the wound. It may be a pipe with a chisel-like bit on the lower end, or a hatchet with built-in calibrated pump. Chisel types are directed at the base of the tree. Hatchet types are used at any convenient level. Injections are usually spaced 1 to 4 inches apart, depending on species and chemical.

Injectors Apply Herbicides in Continuous Frills or Spaced Cuts in the Lower Portion of the Tree Trunk.



Herbicides used in injectors should be water-soluble salts. They are usually used full-strength but can be used diluted in unmetered injectors. Esters are less effective.

- **directed sprayers**—Some herbicides that control weeds can also damage trees. Hand sprayers equipped with shields or with directional nozzles can prevent damage to seedlings. Such equipment also can be mounted on tree planting machines so that weeds can be treated while seedlings are being planted if label requirements are met.

ENVIRONMENTAL HAZARDS

The most serious adverse effects of misuse of forest pesticides are:

- Damage to desirable trees.
- Injury to desirable soil organisms.
- Elimination of desirable predator and pollinator insects.
- Unwanted changes in wildlife habitat.
- Drift damage to adjacent crops.
- Direct poisoning of nontarget birds and mammals.
- Injury to fish from application to open water.
- Soil erosion from prolonged devegetation by repeated use of residual herbicides.

Some adverse effects are likely even with correct use practices. Pest control decisions must minimize the adverse effects and weigh them against the benefits.

Every part of a forest changes somewhat when another part is removed. Since pesticides act by

removing living things, the entire forest responds when a pesticide is used. Although the target could be the only organism affected directly, other organisms may be affected indirectly if they depend on the one(s) removed.

Removing any kind of plants, for example, can help the ones that remain to grow better, whether they are wanted or unwanted.

Weigh the environmental consequences of pesticide use against those of nonuse. The adverse effects of *not* using a pesticide may last for many decades in a forest. These effects may include:

- continuing weed problems which may keep desirable trees from growing,
- insect epidemics which may totally destroy the forest or change the species composition,
- loss of seedlings in nurseries, and
- an increase in the time needed for reforestation.

HUMAN HAZARDS

Pesticides used in forests seldom come in contact with humans at exposure rates high enough to cause injury. The risk is greatest for applicators, ground personnel, flagmen, or forest workers. Observe all necessary safety precautions during and after pesticide application.

For additional information on human and environmental hazards of pesticides, see "Pesticide Application And Safety Training".